National Aeronautics and Space Administration

COMMERCIAL CREW PROGRAM

NAC Space Operation

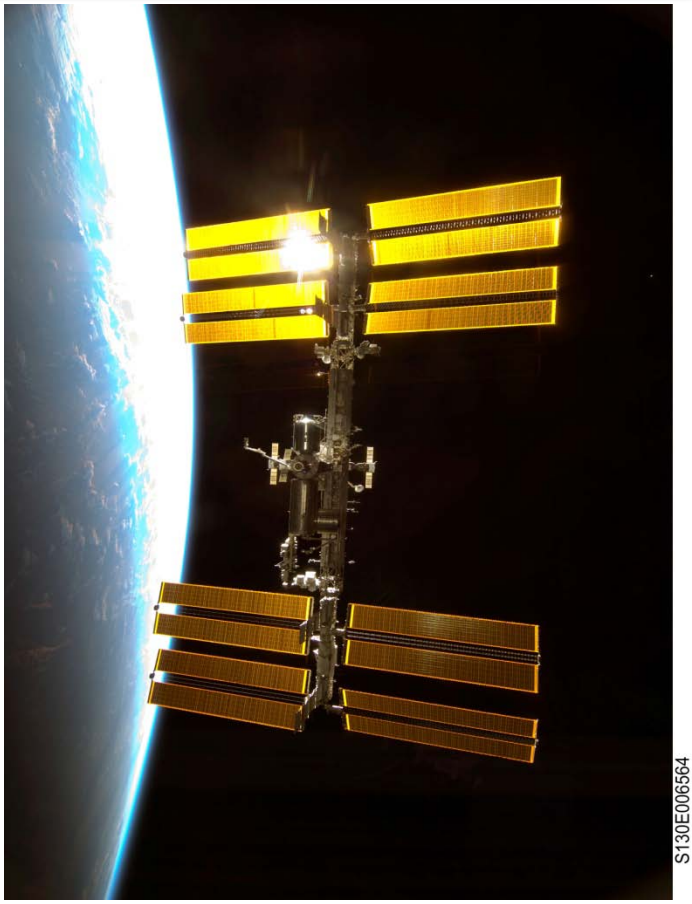
Status Brief

E. Mango

May 2011

Program Approach

- The 2010 NASA Authorization Act established commercial crew as the primary means for ISS crew transportation.
- The program objective is to facilitate the development of a U.S. commercial crew space transportation capability for achieving safe, reliable, and cost effective access to and from LEO and the International Space Station (ISS) by late 2016.
  - Use a non-traditional acquisition and partnering approach
  - Competition is a fundamental aspect of the strategy
  - NASA could purchase commercial services to meet its ISS crew transportation needs



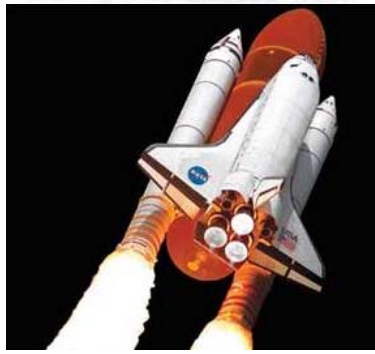
Commercial Crew Program (CCP)

CCP is leading NASA's efforts to develop an American-made commercial capability for crew transportation and rescue services to the station following this year's retirement of the space shuttle fleet.

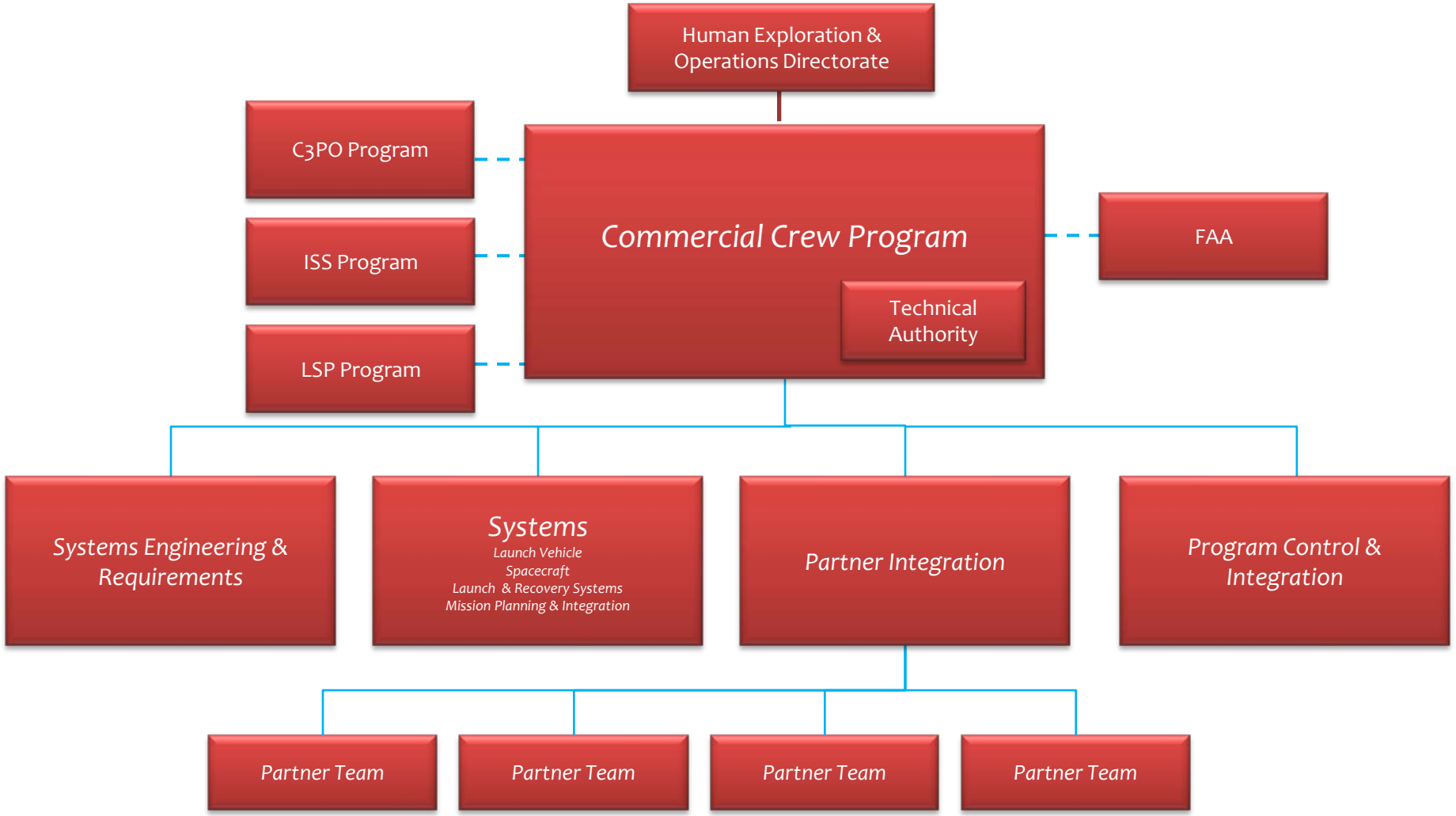
- Program Manager will reside at KSC
- Deputy Program Manager located at JSC

Program Mission

- Manage the investment in the development of commercial end-to-end transportation systems
- Manage the CTS (Crew Transportation System) certification process
- Lead the technical and programmatic partner integration and approval functions



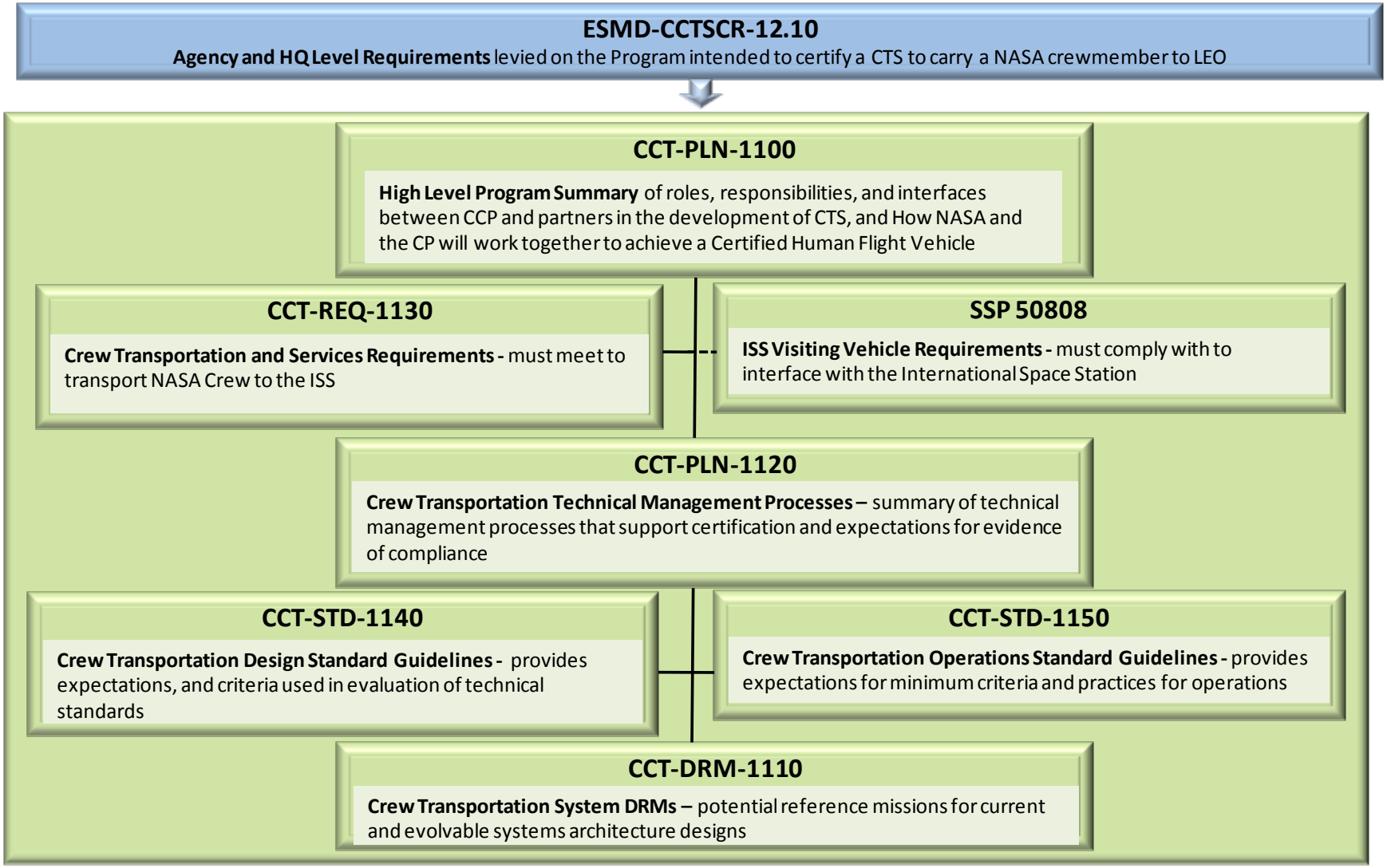
Commercial Crew Program Organizational Structure



NASA's CCP Program Boards

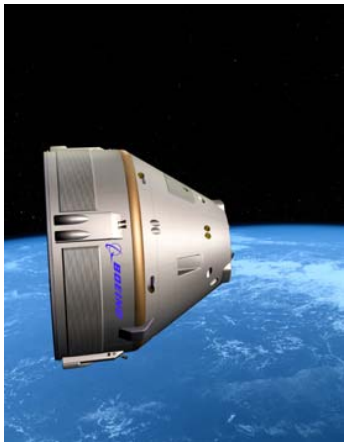
- CCP Program Control Board (PCB)
  - Establish and manage changes to NASA's Program baseline
  - Specific tasks for CCDev2 include:
    - NASA Budget resource allocations
    - Assess progress of Commercial Partners at Milestone Reviews
    - Manage investment risk and determine success or actions required
    - Approve Milestone Evaluation Reports
    - Authorize Milestone Payments
    - NASA schedule
    - NASA Program Risk Management
- CCP Technical Review Board (TRB)
  - Supports PCB with technical management, systems engineering and integration for Program requirements and assessments of safety or technical risk issues
  - Integration and resolution of NASA technical issues
  - Recommends independent assessments based on Partner Integration Team request/input or as determined by TRB

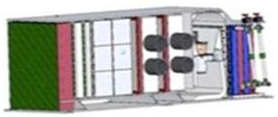
NASA Commercial Crew Requirements Documents



Commercial Crew Development

Phase 1 Initial Design Concepts





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BOEING

PARAGON
SPACE DEVELOPMENT CORPORATION

SNC SIERRA NEVADA CORPORATION
Space Systems

ULA®
United Launch Alliance

Commercial Crew Development – CCDev2

- Four companies were selected for award:
  - Blue Origin: $22M
  - Boeing: $92.3M
  - Sierra Nevada: $80M
  - SpaceX: $75M
  - Total = $269.3M
- Within the selected concepts, there is diversity in spacecraft approaches (two capsules, a lifting body, and a biconic shape spacecraft) and in the launch vehicles they propose to use.
- NASA believes this portfolio of concepts best meet the goals of CCDev 2 within the available funding. It will significantly mature the design and development of system elements and accelerate the availability of commercial crew transportation system capabilities.

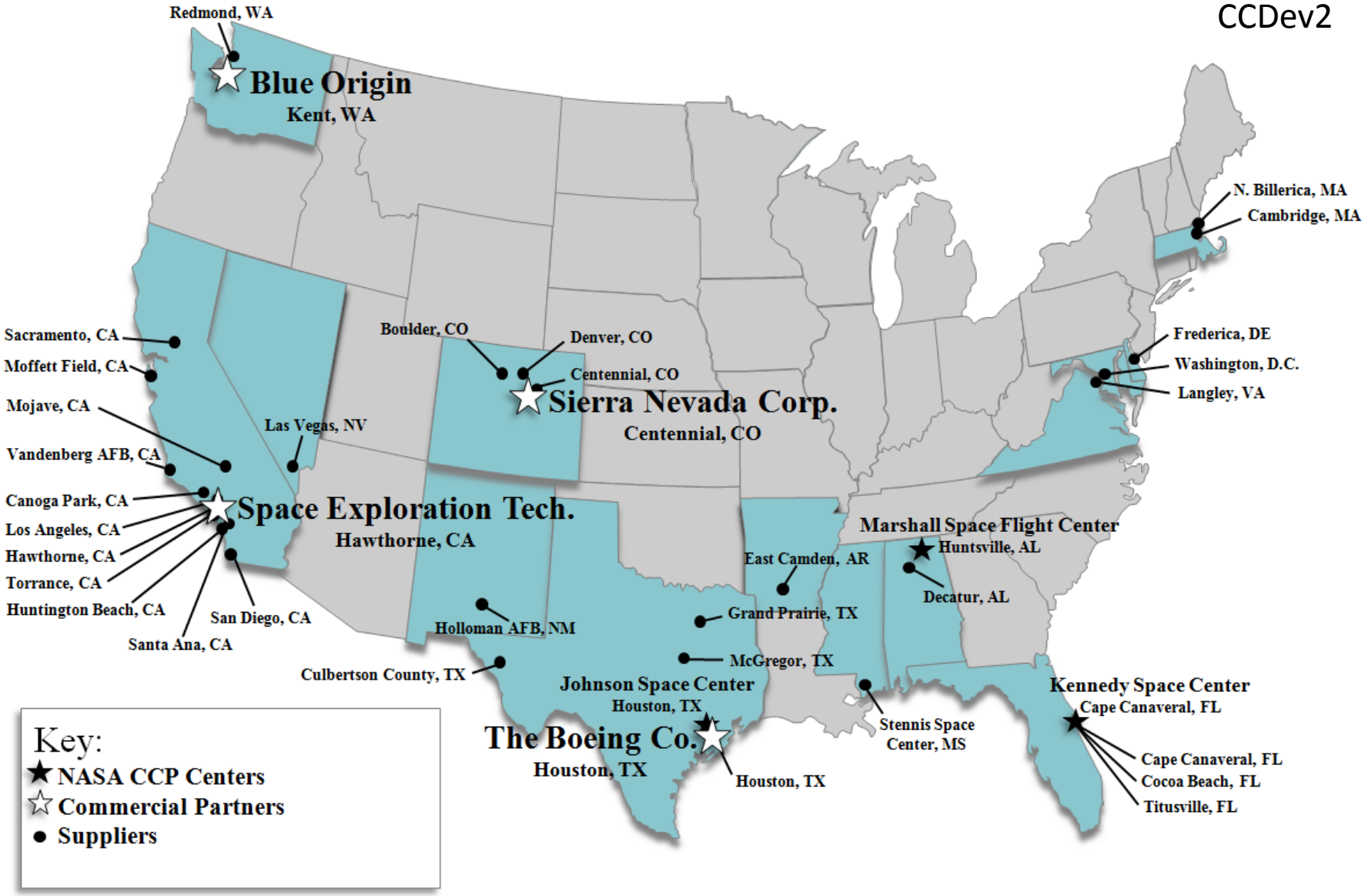
BOEING

SIERRA NEVADA CORPORATION
Space Systems

SPACEX

Commercial Crew Program
Commercial Partners and Suppliers

CCDev2



Commercial Crew Development – CCDev2

System Description: Crew transportation system comprised of a reusable biconic Space Vehicle launched first on an Atlas V launch vehicle and then on Blue Origin's own Reusable Booster System.

CCDev2 Content: Mature Space Vehicle design through System Requirements Review, mature the Pusher Escape System, and accelerate engine development for Reusable Booster System.

CCDev2 Milestones (partial):

- Space Vehicle Mission Concept Review
- Space Vehicle System Requirements Review
- Pusher Escape Ground Firing
- Pusher Escape Pad Escape Test
- Reusable Booster System Engine Thrust Chamber Assembly Test

NASA investment: $22M

Commercial Crew Development – CCDev2

BOEING

System Description: Commercial crew transportation system comprises the reusable CST-100 spacecraft, launch services, and ground systems. CST-100 is compatible with multiple launch vehicles and is reusable for up to ten missions.

CCDev2 Content: Mature CST-100 design through Preliminary Design Review & perform development tests.

CCDev2 Milestones (partial):

- Phase 0 Safety Review
- Launch Abort Engine Fabrication & Hot Fire Test Demo
- Landing Air Bag Drop Demonstration #1
- Phase 1 Wind Tunnel Tests
- Parachute Drop Tests Demonstration
- Launch Vehicle Emergency Detection System/Avionics System Integration Facility Interface Simulation Test
- Preliminary Design Review

NASA investment: $92.3M

Commercial Crew Development – CCDev2

SIERRA NEVADA CORPORATION
Space Systems

System Description: Dream Chaser is a reusable, piloted lifting body, derived from NASA HL-20 launched on an Atlas V.

CCDev2 Content: Mature Dream Chaser design through a Preliminary Design Review with some subsystems to Critical Design Review, and conduct significant hardware testing.

CCDev 2 Milestones (partial):

- System Requirements Review
- Canted Airfoil Fin Selection
- Cockpit Based Flight Simulator
- Vehicle Avionics Integration Laboratory
- System Definition Review
- Flight Control Integration Laboratory
- Engineering Test Article Structure Delivery
- Separation System Test
- Preliminary Design Review

NASA investment: $80M

Commercial Crew Development – CCDev2

System Description: The crew transportation system is based on the existing Falcon 9 launch vehicle and Dragon spacecraft which have been designed since inception for crew carriage with relatively minimal modification. Both the longest-lead and most safety-critical system is the Launch Abort System.

CCDev2 Content: Mature the flight-proven Falcon 9 / Dragon transportation system focusing on developing an integrated, side-mounted Launch abort System.

CCDev2 Milestones (partial):

- Launch Abort System (LAS) Propulsion Conceptual Design Review
- LAS Propulsion Component Preliminary Design Review
- Crew Accommodation Concept Prototype and In-Situ Trials (2)
- LAS propulsion component initial test cycle
- Concept Baseline Review

NASA investment: $75M

SPACEX

Partner Integration Team Structure

- Partner Manager
- Deputy Partner Manager
- Technical Integration Lead
- Systems Lead (s)

Dedicated Full Time Members

- Engineering
- Flight Crew Office
- Crew Health & Medical
- Operations
- Safety & Mission Assurance

CCP Matrix Staff Participation As Needed

- **System & Discipline Specialists**
  - ***Struc, Mech,Guid, Nav, Control, Prop, Pwr, Therm, Comm,TPS, Aero, Crew Sys, ECLSS, etc.***
- **NESC**
- **NSC**

External to CCP Participation As Needed

- A successful Commercial Crew Program will:
  - Transform human spaceflight for future generations
  - Result in safe, reliable, cost effective crew transportation to LEO and for the ISS
  - Reduce reliance on foreign systems
  - Free NASA's limited resources for beyond-LEO capabilities